

# THE VENUS TABLES OF *AMMIZADUGA*

A SOLUTION OF BABYLONIAN  
CHRONOLOGY BY MEANS OF  
THE VENUS OBSERVATIONS  
OF THE FIRST DYNASTY

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*With Tables for Computation by*  
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## CHAPTER V

### PAST STUDIES OF THE SUBJECT

AMONG the tablets discovered by SIR HENRY LAYARD in his excavation of the library of Ashurbanipal at Kuyunjik, the ancient Nineveh, in 1850 and following years, and deposited in the British Museum, is a document in the Assyrian language (K. 160), the cuneiform text of which was published by SIR HENRY RAWLINSON and GEORGE SMITH, *Cuneiform Inscriptions of Western Asia*, vol. iii (1870), pl. 63, under the title of 'Table of the Movements of the Planet Venus and their influences'. This text, which as we know contained serious errors, was reprinted with interlinear transcription and translation by SAYCE, *The Astronomy and Astrology of the Babylonians, with Translations of the Tablets relating to these Subjects*, TSBA. iii (1874), pp. 316-39. The translation is fairly successful as a rendering of the astronomical contents, but it expresses the different phenomena categorically, instead of hypothetically, and the duration of invisibility of Venus is in each case given as the date of reappearance measured from the date of disappearance. This latter error is of purely grammatical importance. It is not surprising that the eighth line, which contains the year-formula of the eighth year of the reign of Ammi-zaduga, expressed as usual in the Sumerian language, should have been wrongly read and, in consequence, not recognized as a date. The system of dating by year-formulae was first made known by GEORGE SMITH in his paper *Early History of Babylonia*, TSBA. i (1872), pp. 45 ff. SMITH's paper gave translations of many such formulae, but no cuneiform texts. There was, therefore, nothing to suggest that the words in the eighth line were such a formula. In SAYCE's paper the text and translation are not accompanied by any commentary or other attempt at the explanation of the tablet, which is briefly described<sup>1</sup> as a long table of the phases of Venus. How completely it could be misconceived is shown by a reference made by LENORMANT, *La Divination* (1875), p. 21, note, who refers to SAYCE's paper and describes the document as a complete table of the movements of the planet and of auguries from its positions during one year.

A translation of the text with an astronomical discussion was contributed by BOSANQUET and SAYCE under the title of *The Babylonian Astronomy*, No. 3. *The Venus Tablet* to MN. 40 (1880), pp. 565-78. The translation differs very little from that which SAYCE had published six years earlier, and contains substantially the same false interpretation of the line which is now known to contain the year-formula. In this paper BOSANQUET and SAYCE went far in the way of interpreting the tablet. They realized that it consisted of three parts, the first of which contained a series of observations of Venus including last appearance in the east, first appearance in the west, last appearance in the west, first appearance in the east, continued through at least six synodic periods, the day of the month of each phenomenon and the duration of invisibility being recorded. The rest of this part they considered too imperfect for analysis. The second part they found to be different in style and grammar from the rest; and, though it contained phenomena of Venus similar to those contained in the first part, they noticed that these were made to recur at uniform intervals; by a not unnatural misunderstanding they concluded that it gave Venus a synodic period six months too long, and decided that it was a fabrication by some person wholly

unacquainted with the phenomena. The third part was found to be analogous to the first and to consist of a continuous series of observations. BOSANQUET and SAYCE were in doubt whether the calendar to which the observations were referred was a lunar calendar or one where each month contained 30 days. They realized that the date of a conjunction of Venus and the Sun with its attendant disappearance and reappearance of the planet recurred at periods of just under eight years, and computed that Venus would return to the same phase at the same date in the sidereal year at the close of a period of 235.182 sidereal years. They went on to say :

‘It would be quite possible in this way to calculate the dates at which the observations of this tablet could have been made ; but a conjectural element enters into the reconstruction of the calendar of the observations. And as there is nothing to associate these observations with historical dates, there is no possibility of a real contribution to ancient history in this case.’

The astrological influences of the phases were not discussed in this paper.

Though unable to date the observations astronomically, they observed that the antique style and the fact of their belonging to the collection supposed to have been made by Sargon of Agade tended to refer them to a period older than 1700 B. C.

BOSANQUET and SAYCE’s analysis of the observations may be made clearer to those who are not astronomers by a little explanation of the successive phenomena of the planet Venus. Venus, moving in an orbit smaller than the Earth’s, must always appear to be much in the same direction as the Sun. She may sometimes be to the left of the Sun, sometimes to the right of him, but she is never more than  $48^{\circ}$  distant from him, and at her greatest distance crosses the meridian between three and four hours before or after him. The result is that she can only be seen in the morning before sunrise or in the evening after sunset, and if she is very near the Sun she cannot be seen at all, except that very clear-sighted people may sometimes see her near the Sun in broad daylight. We have no mention of any such observation at Babylon. Venus is therefore in succession :

- (1) the evening star, Greek Hesperos and Latin Vesper ;
- (2) invisible ;
- (3) the morning star, Greek Phosphoros, Latin Lucifer ;
- (4) invisible ;

and then the evening star again.

The synodic period or mean duration of the four phases is 584 days, while the length of the individual phases is variable. Five of these periods will last 2,920 or, more exactly,  $2,919\frac{1}{2}$  days ; eight solar years are 2,922 days ; 99 lunar months are  $2,923\frac{1}{2}$  days. The result is that a particular phase of Venus recurs at the same season of the year and month at intervals of eight years ; only the return is not absolutely exact, for it falls about  $2\frac{1}{2}$  days earlier in the solar year and 4 days earlier in the lunar month. From this it follows that if a conjunction of Venus with the Sun falls two days after new moon, it may be expected to fall two days before new moon eight years later, but will not fall near new moon again till 64 years after the first date, when eight intervals of four days will have amounted to a complete month. At this recurrence the conjunction will fall 17 days earlier in the solar year, so that if the exact position of the calendar months in the solar year is not fixed, a phase of Venus may recur in the same month and on or near the same day of the month at intervals of 8, 56, 64, and even 112 or 120 years. When Venus at conjunction is between the Earth and the Sun, she is said to be at inferior conjunction ; when the Sun at conjunction with Venus is between her and the Earth, Venus is said to be at superior conjunction.

The notice of the tablet by BEZOLD, *Catalogue of the Cuneiform Tablets in the Kouyunjik Collection of the British Museum*, vol. i (1889), p. 42, recorded the fact that it is in neat Assyrian characters, but added nothing further to our knowledge. It is there described as 'Astrological forecasts'. The second volume of this catalogue, also by BEZOLD (1891), contains notices of two other tablets which, as we now know, contain some of the same appearances and disappearances of Venus as K. 160. These are K. 2321 + K. 3032 and K. 7072. The first of these is described as 'Babylonian Astrological forecasts, which form, according to the colophon, the 63rd tablet of the Series "When Anu and Enlil"'.<sup>1</sup> The obverse begins "...na disappeared in the west, remaining absent in the sky 3 days, and"'.<sup>2</sup> K. 7072 is thus described, 'Fragment out of the middle,  $2\frac{1}{2}$  in. by  $1\frac{1}{2}$  in. 7 + ... lines. Fragment of a text containing astrological forecasts for the various months, taken from observations of the Star Nin-si-an-na'.<sup>3</sup>

In the fourth volume of the catalogue (1896) BEZOLD deals with three more tablets which are now known to preserve parts of our text. One of these, S. 174, is described as 'Fragment out of the middle  $1\frac{7}{16}$  in. by  $\frac{7}{8}$  in.; 9 + ... lines. Part of a text containing astrological forecasts taken from observations of the Sun', a somewhat misleading description of a text which gave little indication of its character. Another, Rm. 134, is described as 'Left half, upper portion,  $2\frac{5}{16}$  in. by  $2\frac{1}{4}$  in.; 10 + ... lines. Part of a text containing astrological forecasts similar to those of K. 7072'. Then follow the words in cuneiform with which each paragraph begins. The remaining text, Rm. II 531 is described as 'Fragment of the left half,  $2\frac{1}{4}$  in. by  $1\frac{5}{8}$  in.; 15 + ... lines; partly vitrified. Part of a text containing astrological forecasts for the various months, taken from observations of the "Nin-si-an-na," and other stars'. As will be seen from LANGDON's study, the document is not arranged by months, and is not taken from observations of any star except Ninsianna, i.e. Venus.

In 1898 JASTROW dealt briefly with K. 160 in his *Religion of Babylonia and Assyria*, pp. 371, 372, and translated select passages from the first and second part of the document. His translation differs in detail from SAYCE's and in particular he correctly translates the intervals of disappearance as such; he recognized the hypothetical form of some of the appearances in the second part of the tablet, but still treats the statements in the first part as categorical; but his suggestions for the translation of the eighth line were equally unhappy with his predecessor's. He also made the suggestion that the document belonged to the series 'Illumination of Bel', i.e. to the series 'When Anu and Enlil', a conjecture that was destined to be confirmed by SCHIAPARELLI's identification of this document with that represented by K. 2321 + K. 3032. On the whole JASTROW, unlike BOSANQUET and SAYCE, showed more interest in the astrological than in the astronomical significance of the documents.

In 1899 J. A. CRAIG published in *Assyriologische Bibliothek*, xiv, cuneiform texts of the documents belonging to the series known as the 'Illumination (?) of Bel', so far as he was able to recover them. No. 46 in this volume contains the text of K. 2321 + K. 3032 and of K. 3129, which professes to be the 63rd of that series. It is no discredit to CRAIG that his text should have been found to contain errors which are corrected by LANGDON in this volume.

So far attention had nowhere been drawn to the partial identity of any of these different texts dealing with Venus phenomena. This was reserved for the Italian astronomer SCHIAPARELLI, whose 'Venusbeobachtungen und Berechnungen der Babylonier', *Das Weltall*, 6. Jahrg.,

<sup>1</sup> BEZOLD gives the cuneiform text of this phrase. I owe this translation to LANGDON.

<sup>2</sup> LANGDON's translation.

<sup>3</sup> Printed in cuneiform.

Heft 23, 7. Jahrg., Heft 2 (1906), constitutes a most important study of the character and interpretation of these texts. He recognized that K. 2321 + K. 3032 contains fragments of two documents, one of which, on the obverse, is the same as the main document of K. 160, though, since both tablets are imperfect, the greater part of each lies outside the range of the other. This document, which he called C, he recognized as containing a continuous series of observations of appearances and disappearances of Venus, preserved for 21 consecutive years. He conceived that in its complete state it would have contained three Venus periods or 24 years. The document on the reverse of K. 2321 + K. 3032 which he called B was, he found, a series of actual observations of disappearances and appearances of Venus arranged according to the months in which they occurred, without any mention of the years to which they belonged. Relying unduly on the accuracy of the numbers in the published texts, he held that these observations were entirely distinct from those in Document C. The insertion which forms the second part of K. 160, which SCHIAPARELLI called Document A, was found by him to be a table by means of which, given the time of any reappearance of Venus, the time of the next disappearance and reappearance could be computed, assuming mean intervals between the different phenomena. With a mean lunation of 29.5 days, he found that the intervals used implied a synodic period of 577.5 days, about 6.4 days less than the true period of 583.9 days. He noticed the close similarity of all these texts in form and character and in terminology, and laid stress on their all using exclusively what he regarded as the rare name *Nin-si-an-na*, or, as he wrote it, *Nin-dar-an-na*, for Venus, from which he inferred that the three documents had their origin in the same astrological school, and therefore, since Document A professes to be copied from a Babylonian original, he inferred that all three documents must be of Babylonian origin. BEZOLD had already recognized that, while K. 160 is in Assyrian script, K. 2321 + K. 3032 is in Babylonian script. SCHIAPARELLI, while exhibiting in full the recorded dates of disappearance and reappearance with the recorded intervals of invisibility, as he found them in the printed cuneiform texts, and in the case of Document C assigning them to their proper year in the series of 21 years, did not attempt a translation of any of the documents, but illustrated their character with a few examples. Like SAYCE, he treated the expressions as categorical, but like JASTROW, to whom he does not refer, he translated the references to intervals of invisibility correctly. While realizing that the real value of the record for the Babylonians lay in the astrological omens, he neither collected these nor dealt with them in detail.

Among the most interesting parts of SCHIAPARELLI'S paper are his astronomical examination of Documents B and C and his attempt to determine the date of the observations contained in the latter document. He assumed that the dates exhibited on the tablets were not all observations in the modern sense, but that in a minority of instances observation had been impossible, and the recorded dates had been deduced by computation from other observations. Neglecting what appeared to be doubtful dates, he found that the intervals of invisibility at inferior conjunction yielded an *arcus visionis* of  $5.42^\circ$ , and with this value he proceeded to determine the series of years which would best agree with the recorded dates of the Venus phenomena. Since the tablets were found at Nineveh, he assumed that the observations must be older than the destruction of that city, which was then placed in 606 B.C., while an upper limit seemed to be provided by the reference in Document A to a disaster of the *ummān-man-da* or Manda hordes, with which he identified the *ummān-matti* (properly 'army of the land'), which suffers disaster in Documents B and C. Believing that the *ummān-man-da* made their first appearance in

history in the eighth century before Christ, and being impressed by their complete absence from the extensive records of Ashurnasirpal II, Shalmaneser III, and Shamshi-Adad V, whose reigns extend from 882 to 810 B. C., he concluded that his inquiry could be limited to the seventh and eighth centuries before Christ. He found that the solution depended on the assumed position of the Babylonian months in the solar year. With a mean date for the 1st of Nisan 16 days after the spring equinox, he found 657 B. C. as the first of the series of 21 years; with mean 1st of Nisan 18 days after the equinox he found 665 B. C.; with mean 1st of Nisan 11 days before the equinox he found 812 B. C., in which case the 17th year, with which the defeat of the *ummān-man-da* was connected, fell in the year 796 B. C. and would, so he thought, be the earliest well-attested reference to that people. Finally he found that with the mean 1st of Nisan five or seven days later than the equinox, the data would be satisfied by a series of years beginning in 868 or 876 B. C. respectively. He left it to orientalists to determine whether so early a reference to *ummān-man-da* was possible. He felt, however, that the dates 657, 665, and 812 B. C. were more probable, but that new discoveries and investigations would be necessary to decide the question. As an example of method this work is excellent. Unfortunately for these conclusions, the Manda are now known to have been mentioned as far back as the Hittite laws of the seventeenth century B. C. A clue to the date had yet to be discovered.

In 1908 appeared the two parts *Sin* and *Ishtār* of VIROLLEAUD'S *L'Astrologie Chaldéenne, Texte Cunéiforme*, the former of which contained those documents believed to belong to the book entitled *enuma* (Anu) <sup>iii</sup> *Bel* (now read *enuma Anu* <sup>iii</sup> *En-lil*) which dealt with the Moon and the latter those which dealt with the fixed stars. The frontispiece to *Sin* is a photograph of K. 160. No. XII in *Ishtār* is a composite text, in which lines 1-15 are lines 1-15 of the obverse of K. 2321 + K. 3032, lines 16-27 are a conflate text based on lines 16-27 of K. 2321 + K. 3032 and lines 1-14 of the obverse of K. 160, and lines 28-43 are lines 15-30 of K. 160, ending where the series of observations is interrupted at the conclusion of the first part of that document. No. XIII is the second part of K. 160. No. XIV is the third and concluding part of K. 160. No. XV is the reverse of K. 2321 + K. 3032. A transcription of these texts was published by VIROLLEAUD in 1909 in *L'Astrologie Chaldéenne, Transcription, Ishtār*. The same editor published in 1910 a *Supplément* to his *L'Astrologie Chaldéenne*, in which he included as No. XLI the cuneiform text and transcription of Rm. 134, and as No. XLII the cuneiform text and transcription of K. 7072. He also included the cuneiform text of S. 174 in his 'Fragments astrologiques', published in the same year in *Babyloniaca*, iii. 285.

1910 is also the date of FATHER KUGLER'S *Im Bannkreis Babels*. In a note on pp. 147-8, he showed that, reckoning the month at a conventional length of 30 days and the year at a conventional length of 360 days, the insertion in K. 160—SCHIAPIARELLI'S Document A—implies a synodic period of 587 days.

Next in order of time comes JASTROW'S German treatise, *Die Religion Babyloniens und Assyriens*, II. Band, II. Hälfte, pp. 617-25, which bears on its title-page the date 1912, though the earlier part of the half-volume was in the hands of scholars in time to be used by them in works which appeared in 1911 and 1912. In this treatise JASTROW makes use of VIROLLEAUD'S work, but appears to have been ignorant of SCHIAPIARELLI'S. He gives a translation of the texts of the two documents which SCHIAPIARELLI had called B and C, beginning with the 12th line of the obverse of K. 2321 + K. 3032. He regards the two documents as a single text broken by a gap of unknown length. Though he recognizes that the dates on the tablets are

derived from observation, he attempts no astronomical control, and his emendations of dates are in consequence unfortunate. The references to the appearances are recognized as hypothetical throughout. The mysterious phrase in the eighth line of the obverse of K. 160, the twenty-first of the obverse of K. 2321 + K. 3032, once more has a false meaning found for it, but JASTROW's interest was mainly in the omens and in their relation to the phenomena. He imagined that he had discovered that a medium interval of invisibility was accompanied by a favourable omen, while an interval which was short or long for its particular phase was accompanied by an unfavourable omen, a somewhat curious result since in the same work he translates in full Sm. 781, col. ii (VIROLLEAUD, *Supplément*, No. XXXVII), which gives omens in good general agreement with those of K. 2321 + K. 3032, but makes them depend entirely on the month in which Venus disappears, giving different omens according as the disappearance is in the morning or in the evening, and taking no notice of the duration of invisibility. JASTROW also translates the insertion (SCHIAPARELLI's A) but in view of the schematism of its intervals of visibility and invisibility, and, as he thinks, of its omens in relation to the season of the year for the different phases, he suspects that it is merely a school exercise.

In 1911 WEIDNER contributed to *Memnon*, v 29-39, a paper entitled 'Die astronomische Grundlage des Venusjahres', in which he included a transcription and translation of this insertion, deduced from it the knowledge of a synodic period of Venus amounting to 584 days, and by a somewhat bold argument tried to show that the document in its original form dates from the end of the fifth millennium before Christ.

In 1912 KUGLER produced Teil II, Heft I, of the second book of his *Sternkunde und Sternendienst in Babel*. Pp. 257-311 of this publication are concerned with the two Venus tablets which had engaged the attention of SCHIAPARELLI and with discussions arising out of them. He writes with full knowledge of the work of his predecessors, but gives neither full text nor full translation of the documents, nor even a full *résumé* of SCHIAPARELLI's criticism on which he builds. In order, therefore, to follow KUGLER in detail it is necessary to refer to the older studies of the documents. He has, also, chosen to rename the documents and in so doing has used SCHIAPARELLI's names in a new sense. Thus SCHIAPARELLI's A is KUGLER's B. The text of SCHIAPARELLI's B, found on K. 160, is KUGLER's A, and the two texts, B and C in SCHIAPARELLI's notation, found in K. 2321 + K. 3032, are called by KUGLER, A'. I prefer, with SCHIAPARELLI, to use the letters of the alphabet as names for documents, in preference to KUGLER's system, in which the nomenclature is partly by documents and partly by tablets, but in order to avoid the confusion of using a symbol in a different sense from that in which it has been used by KUGLER I will in the present study use the terms L, M, and N, which have not hitherto been used in this connexion.

L is the document in which the phenomena are arranged in chronological order, and is equivalent to SCHIAPARELLI's B. It is found on K. 160, Obv. 1-29, Rev. 34-45; K. 2321, Obv.; Rm. II, 531; W. 1924, 802, Obv.

M is the document in which the phenomena are arranged in calendrical order, and is equivalent to SCHIAPARELLI's C. It is found on K. 2321, Rev.; K. 7072; Rm. 134; S. 174.

N is the document containing an artificial series of phenomena, inserted in K. 160, and is equivalent to SCHIAPARELLI's A. It is found on K. 160, Obv. 31-Rev. 33.

KUGLER devotes some space to a more detailed demonstration of the conclusion, which he had drawn from Document N, that its compiler regarded 19 months 17 days or 587 days as the con-

ventional length of the synodic period of Venus, and replies to SCHIAPARELLI's deduction of a period of  $577\frac{1}{2}$  days and WEIDNER's deduction of one of 584 days. KUGLER is undoubtedly right, so long as we recognize that the conventional month is not an exact period independent of the calendar month, but is merely the calendar month reckoned inexactly. The writer would not expect the synodic phenomena to recur at a mean interval of 587 days precisely, but at an interval of 19 months 17 days which might be treated for purposes of computation as 587 days, but would not be so treated for purposes of observation. The observer would look for a repetition of the phenomena after 19 calendar months 17 days, ignoring intercalary months. It seems impossible to convert this into an exact number of days, and we must not suppose that the writer imagined that he knew the exact number of days in the synodic period.

After a few explanatory remarks KUGLER proceeds to give a transcription and translation of K. 160, obv. lines 1-14, as a specimen of the character of the text. Like the earlier translators he treats the references to phenomena as categorical. Then follows a tabular presentation of the phenomena contained in Document L, so far as it is represented by K. 160. This is followed by a discussion of some length in which very little use is made of K. 2321 + K. 3032, and the impression is created that the discussion was written before KUGLER was aware that the two tablets represented the same document, and was only imperfectly revised afterwards. The discussion begins with a presentation of late Babylonian material illustrating the length of the synodic period of Venus and the intervals between the different appearances and disappearances. He then proceeds to deduce the intercalary years from the intervals separating the phenomena recorded in K. 160. Here he fails to show his usual arithmetical skill. Using \* for a year with second Adar and \*\* for a year with second Ulul, he gives the following as intercalary years. [For convenience I number the years from the beginning of Document L, adding 6 to the number given by KUGLER.] (9)\* or (10)\*\*, (11)\*\*, (14)\*\*, (17)\*, (19)\*\*, of which (11)\*\* and (19)\*\* are directly attested. If he had reckoned the intervals accurately he would have found (9)\* or (10)\*\*, (11)\*\*, (13)\*\*, (19)\*\*, (20)\*\* or (20)\*.<sup>1</sup> Or, accepting his conjectural emendation of the western rising in the 13th year, he should have had (9)\* or (10)\*\*, (11)\*\*, (13)\* or (14)\*\*, (19)\*\*, (20)\*\* or (20)\*. These will be discussed later along with the other intercalary years.<sup>2</sup>

Then follows a critical and in large measure successful investigation of errors made by copyists, followed by a very unconvincing attempt to detect and explain errors which appear to go back to the parent document. There remains a residuum of dates which KUGLER regards as trustworthy and which are reserved for an astronomical test when a clue shall have been found to the age of the tablet. The dates so selected have at least the merit of not being *prima facie* incoherent. One group among them is affected by textual uncertainty. The others are probably among the best in the series.

KUGLER next endeavours to prove that the constant values used for intervals in Document N are derived from the figures contained in Document L, or in that part of it which is represented by K. 160. The whole argument appears to be a piece of arithmetical jugglery. It is based upon arbitrary assumptions as to the length of mean lunation used by the author of N, now 30 days, now  $29\frac{1}{2}$  days, as suits KUGLER's convenience. It is based on arbitrary assumptions

<sup>1</sup> The dates of observations at inferior conjunction in Adar of the 17th year and at superior conjunction (Sivan-Ulul) in the 20th year show that there was only one intercalation between these conjunctions.

<sup>2</sup> KUGLER is in fact merely repeating an error made by SCHIAPARELLI, who found that Years 9, 11, 14, 17, and 19 were intercalary.



as to his use of intercalary months, and it is based on arbitrary assumptions as to the extent to which the corruptions, existing in K. 160, were in the text used by the author of N. It also assumes what seems very doubtful, that the first five years of the text of L were already missing in the older text from which N is derived, while the sixth year, which is also missing from K. 160, is supposed to have been present.

Then KUGLER announces his great discovery, that the misunderstood words in line 8 of the obverse of K. 160, line 21 of the obverse of K. 2321 + K. 3032, [are the year-formula of the eighth year of Ammizaduga, and this announcement is followed by a table giving the complete series of dates recorded in Document L as obtained from a combination of K. 160 with the obverse of K. 2321 + K. 3032, such a table as SCHIAPARELLI had previously compiled. Here it is shown that the year-formula in question belongs to the eighth year of the twenty-one years of the document, which, as KUGLER rightly concludes, contains the twenty-one years of the reign of Ammizaduga.

Then comes an exposé of the dates on the reverse of K. 2321 + K. 3032 (Document M). KUGLER ignores SCHIAPARELLI's recognition of these as a single series of observations arranged according to the months in which they fell, and breaks them up into three series. First he finds a series of four pairs of observations near inferior conjunction arranged in calendrical order, then five pairs near superior conjunction the order of which he does not explain, and finally three pairs of observations consisting of one at inferior, one at superior, and another at inferior conjunction. He supposes that the two first of these three are in chronological order, but infers from the duration of invisibility in the last that it cannot follow chronologically its predecessor on the tablet. On the whole he realizes that these observations are not chronologically continuous with those in Document L, and pays no further attention to them. He also ignores the astrological omens.

Then he resumes his comparison of the dates of Document L with those of the reign of Ammizaduga and points out that the leap-years in the reign of Ammizaduga known to us through contracts are 4\*, 10\*\*, and 11\*\*, where, as before, \* indicates a year with second Adar and \*\* a year with second Ulul. This, as he points out, is the only example known to us of a second Ulul being intercalated in two successive years,<sup>1</sup> and this is supported by the intercalations in Document L, where, as has been seen, a second Ulul is directly attested in the eleventh year, while the tablets imply either a second Adar in the ninth year or a second Ulul in the tenth year and are therefore consistent with a second Ulul in the tenth year.

Having established that the observations belong to the reign of Ammizaduga, KUGLER next seeks an astronomical verification. He points out that each observation of an appearance or disappearance of Venus, being dated by the lunar month, involves a more or less definite relation between the Sun, Venus, and the Moon. The reference to Ammizaduga limits the inquiry to a few centuries, and he assumes that he need only examine dates falling between 2080 and 1740 B.C. He does not regard the position of the Babylonian months in relation to the Julian calendar as absolutely fixed, but thinks it safe on a superficial examination of contracts relating to harvest to suppose that Nisan began not earlier than the middle of the Julian March nor later than the middle of the Julian June. In order to avoid elaborate computations he examines in the first instance one pair only of the dates which he had previously found to be

<sup>1</sup> We now know that second Ulul was intercalated in the 39th and 40th years of Hammurabi, and in the 8th and 9th and again in the 16th and 17th years of Samsuiluna.

trustworthy, the western setting of Venus in the 6th year on Arahšamna 28, followed by her eastern rising on Kislev 1, an interval of three days only, from which he concludes that the inferior conjunction must in that year have been within two or three days of the new moon of Kislev. He then seeks between 2080 and 1740 B.C. for inferior conjunctions between the middle of November and middle of February of the Julian calendar falling within two or three days of new moon. He finds nine such phenomena, but he has for some reason overlooked the conjunction of -1759 February 1. He then proceeds to narrow the selection further by the assumption, which, even if the computed dates of conjunction and new moon were beyond doubt, would not be astronomically justifiable, that the interval between new moon and conjunction must not exceed a day. In this way he has only three solutions left. These would make the first year of Ammizaduga begin in 2041, 1977, and 1857 B.C. respectively. After noticing that of these three dates 1977 B.C. agrees best with the conclusions hitherto attained by Assyriologists and historians, KUGLER proceeds to test it by an astronomical computation of the angular depression of the Sun below the horizon at the time of rising or setting of Venus on a series of dates of first or last visibility of that planet, as given in Document L. The test is made almost entirely by means of observations near inferior conjunction, only two pairs of observations near superior conjunction being subjected to the test. Altogether KUGLER finds two instances where both the dates of evening setting and morning rising are confirmed by computation, four instances where one of the two is confirmed, two instances where both dates would hold good for observations separated by eight or sixteen years from the years implied in the document, and three instances where one observation in each pair would hold good if transferred eight or sixteen years backwards or forwards. He also finds two instances where the date given for evening setting would hold good for morning rising. In the last of these instances, belonging to the 13th year of Ammizaduga, he has exhibited no computation, and it would appear that his statement that Venus should be visible on Ayar 5 of that year is even on his own data erroneous, and should be changed to Ayar 7, which is inconsistent with his proposed correction of the reading in the text. From the frequency with which he has succeeded in explaining apparently false dates by transferences of genuine dates by eight or sixteen years KUGLER infers that the compiler of our Document L had before him a list of observations in chronological order in which several of the dates were missing or illegible and that these have been restored from a document similar to Document M in which the observations were arranged in calendrical order without any indication of the year to which they belonged. To this it may be replied that, so long as the recorded dates are in the neighbourhood of the computed dates, any conceivable discrepancy could be explained by KUGLER's method. If a recorded last visibility falls a few days before, or a recorded first visibility a few days after, the computed date, we merely assume that Venus was missed for a few days. If the difference between observed and computed dates is in the opposite direction or is too long to be explained by this method, we merely transfer the observation eight or sixteen years backwards or forwards, for since the phenomena always recur four days earlier in the lunar month at the end of each eight-years period any discrepancy not exceeding eight days can be explained in this way. The combination of these devices gives a far better result on the assumption that the pair of observations in the 6th year really belongs to that year than on the assumption that it has been transferred eight years. The date 1977 B.C. for the first year of Ammizaduga is therefore supposed to be established as against 1985 B.C.

It remains to compare it with a possible 2041 or 1857 B.C. This time the test is no longer strictly astronomical. As has been remarked in our discussion of BOSANQUET and SAYCE, after the lapse of an eight-years period, a conjunction of Venus falls about  $2\frac{1}{2}$  days earlier in the solar year than it had done at the beginning of that period. In 64 years the date of the phenomenon in the solar year is shifted by 19 days, and in 120 years it is shifted by 35 days. KUGLER doubted whether an astronomical verification would yield a decisively different result so far as the comparison of computed appearances and disappearances of Venus with the lunar calendar is concerned, but he considered it possible to discover by means of literary evidence at what season the months named on our documents fell, and thus to choose between theories which placed those months at perceptibly different seasons of the natural year. With this end in view he began by computing the date of equinox for each year from the 7th to the 21st of Ammizaduga on the assumption that his first year began in 1977 B.C., and the date of the new moon of Nisan for each of these years on the assumption that the months in which the phenomena were recorded had been correctly identified in his astronomical study. This of course included the assumption that his inferences as to the position of intercalary months were correct. As has been seen, he places the beginnings of the 18th, 19th, and 20th years one month too late. When, therefore, he deduces that on the theory in question the mean interval between the equinox and the 1st of Nisan was 35.15 days, we must correct this figure by deducting  $29.53 \times \frac{3}{15}$  days, i. e. 5.91 days, so that the mean interval becomes 29.24 days. In view, however, of the fact that the first and last years of this series both began later than the mean date, KUGLER thought it wise to include the 6th year, which he assumed to be a leap-year with second Ulul. He overlooked the fact that this assumption would place eleven lunar months approximately between inferior conjunction in the 6th year and superior conjunction in the 8th year, an interval too long by one month. It will be seen, therefore, that he places the beginning of the 6th year one month too early, so that his mean interval between equinox and the new moon of Nisan as determined from the 16 years requires to be reduced by  $29.53 \times \frac{2}{16}$  days, i. e. by 3.69 days, or from 34.59 to 30.90 days. Adding 1.50 days for the mean interval between new moon and the beginning of Nisan, he obtains a mean interval of 36 days between equinox and Nisan 1, and fixes the mean position of the latter at April 26 of the Gregorian calendar. Adopting the above revision of the position of his intercalations, we find that April 22 would have been more correct. He notes that the earliest new moon of Nisan in these 16 years fell 23 days before the mean date, and the latest 16 days after the mean date. Making the corrections mentioned above, the extremes should be 29 days earlier and 26 days later than the mean date. KUGLER contrasts this mean date for Nisan 1 with that which he found for the period 358 to 339 B.C., when it was April 4 Gregorian. It will be seen from the table which he published on p. 285 of the study under discussion that if he had chosen to shift his whole chronology by seven Venus periods, or 56 years, all the lunar dates would have fallen 18 days earlier in the solar year, and we should have had April 4 for the mean date of Nisan 1 in the years 6-21 of Ammizaduga as well as in the years 358-339 B.C.

KUGLER then proceeds to demonstrate to his satisfaction that such a transference of the calendar months by 18 days backwards or forwards is inconsistent with the information supplied by those dated contracts which can be connected with agricultural operations. He cites from modern writers the opinion that the Babylonian harvest season begins about May 10 and closes about the end of that month. These dates probably relate to wheat-harvest, and it will be seen

later that they are far too late for barley-harvest, which was the principal harvest in the time of the first dynasty of Babylon, and that the correct date is from about April 10 to May 15, so that KUGLER's error in the date of harvest exactly coincides with the difference between a year beginning in the mean on April 4 and one beginning in the mean on April 26. If, therefore, the evidence which KUGLER has collected supports his chronology on the assumption that his date for harvest is correct, it would support a chronology falling 56 years later, when the correction just mentioned is applied.

KUGLER then produces a series of contracts from KOHLER and UNGNAD's *Hammurabi's Gesetz*. He deals first with contracts to make payments in silver or barley 'at the time of harvest' and finds that these generally imply that the harvest was later than the eleventh month, while six contracts imply that it fell in the twelfth month at the earliest, and two contracts of the reigns of Sinmuballit and Hammurabi would place it at the earliest in the first month. Then he cites from the same source a series of contracts hiring labourers for the coming harvest. The latest dated of these is on the 30th day of second Adar in the 4th year of Ammizaduga, which KUGLER equates with April 30 Gregorian. This he considers fatal to any attempt to throw the chronology 56 or 64 years farther back, which would bring it to May 18 or May 16. Of course, if we threw back the date of harvest 22 days, this contract would tell with equal force against KUGLER's own solution.

KUGLER then proceeds to deal with contracts for letting fields. He gives examples from KOHLER and UNGNAD of such contracts for every month from Arahšamna to Ayar, citing altogether 19 from Ayar, 9 from Nisan, 2 from Adar, 1 from Šabat, 1 from Tebit, 1 from Kislev, and 9 from Arahšamna. A reference to KOHLER and UNGNAD will, however, show that two of the last-named really belong to Tešrit, and KUGLER himself treats one of them as belonging to Tešrit in his discussion. He supposes that contracts dated in Nisan and Ayar were made after harvest, while those dated in other months were made before harvest, and infers that Nisan was the proper harvest month. This argument appears to be very precarious. The agricultural operations of the year would not be concluded until the corn was threshed and divided between landlord and tenant. It may be presumed that a contract for the new year was generally made before these operations were concluded, but it seems unsafe to suppose that such contracts were regularly made after harvest. KUGLER, however, uses it as a means to prove that the chronology cannot be reduced by 56 years, in which case he remarks that Ayar, not Nisan, would be the harvest month, and the Ayar contracts could not be made to fall after harvest. He also supposes that the Arahšamna and Tešrit contracts were made immediately before seed-time, which, according to him, would be in November and December. This he thinks is consistent with the solution which he favours, but inconsistent with one 64 years earlier, which would place these contracts at the end of December. This again appears to be a precarious argument. It should be noted that contracts for letting fields are to be found in KOHLER and UNGNAD in every month of the Babylonian year. KUGLER's selection is far more exhaustive in Nisan, Ayar, and Arahšamna than in the other months, and must not be taken as evidence of the actual distribution of lettings throughout the year. KUGLER's final conclusion is that the contracts by which Babylonian months can be correlated with definite seasons of the year exclude all solutions separated by 56 years or more from that which makes the first year of Ammizaduga begin in 1977 B.C., while solutions differing by less than 56 years from this solution are astronomically inadmissible.

The whole discussion must be regarded as a masterly piece of work, and while it is open to

criticism in detail, the method is excellent. It is to be regretted that KUGLER did not attempt a more complete astronomical computation of the recorded phenomena both on his own and on alternative theories, and also that he adopted a questionable date for harvest, and thus weakened the effect of the contracts as a means of deciding between rival astronomical theories.

The discussion is followed by a chapter on the relative positions of the First, Second, and Third Babylonian Dynasties, which lies outside the scope of my share in the present work.

KUGLER's conclusions met with general acceptance, but doubt was expressed in 1913 by EDUARD MEYER, *Geschichte des Altertums*, 3<sup>e</sup> Aufl. i. 2, pp. 369-72, who, while provisionally accepting KUGLER's chronology, expressed himself unable to check his astronomy or to judge of the correctness of his conjectural emendations of the text. He found the chronology in good agreement with that current in later times in Babylon, but in disagreement with that current in Assyria, and pointed out that it requires us to assume that more than five hundred years (1925 to 1380 B.C.) elapsed without any private documents and with hardly any inscriptions. He therefore regarded it as not excluded that these dates might hereafter be found untenable.<sup>1</sup>

In the following year WEIDNER expressed the opinion that KUGLER's restoration of the chronology of the First Dynasty of Babylon was extremely problematical. See his *Alter und Bedeutung der babylonischen Astronomie*, p. 69, where, founding on a neo-Babylonian tablet published by KING in *Cuneiform Texts*, xxxiii, and on an unpublished duplicate of the same, according to which the vernal equinox appears to be placed on Nisan 15, he drew the inference that at least since the time of Hammurabi Nisan 15 coincided in the mean with the vernal equinox, a conclusion inconsistent with KUGLER's, which appeared to place it 50 days in the mean after the equinox.

In 1915 KING expounded and discussed the new chronology in his *History of Babylon*, pp. 106-18. He mentions KUGLER's three astronomical solutions, and decides with KUGLER for 1977 B.C. as the date of the first year of Ammizaduga on the ground that this agrees with the duration of 368 years which the kings' list assigns to the Second Dynasty, and he finds it supported by both Babylonian and Assyrian statements of a later age.

In 1917 there appeared in MVAG. xx, 1915, 4, a long article by WEIDNER entitled *Studien zur assyrisch-babylonischen Chronologie und Geschichte auf Grund neuer Funde*. On p. 24 of this article WEIDNER announced that an astronomical examination of the Venus tablets would shortly appear, from which it would be seen that the most probable date for the First Dynasty of Babylon lay 168 years later than KUGLER's. This new chronology was brought into connexion with the chronology of Assyria, and WEIDNER maintained that it agreed with all the statements of a later age except those of Nabuna'id.

We learn from a later paper by WEIDNER<sup>2</sup> that the new examination of the Venus tablets was the joint work of himself and NEUGEBAUER and that it involved some corrections of the text. In 1925 SCHNABEL<sup>3</sup> published the fact that the manuscript of this study was lost in the German revolution of 1918.

In 1920 HOMMEL, in an appendix to *Assyr. Bibl.* xxv, Nies, 'Ur Dynasty Tablets', pp. 197-9, expressed the view that the year-formula of Ammizaduga's 8th year was inserted into the Venus tablets by a scribe in the reign of Ashurbanipal, who adopted a system of chronology current

<sup>1</sup> The same criticisms had been expressed by MEYER in *Sitzungsberichte d. k. preuss. Akad. d. Wissenschaften*, 1912, pp. 1063, 1064, except that he did not on that occasion sug-

gest that KUGLER's dates might hereafter be found untenable.

<sup>2</sup> MVAG. xxvi (1921), 2, p. 41.

<sup>3</sup> ZA. xxxvi, p. 113.

from the eighth century B.C. onwards, which placed all early dates about 170 years too high. HOMMEL was to accept KUGLER's identification of the recorded phenomena while accepting a historical chronology falling seven years later than WEIDNER'S. This curious suggestion implies that the scribe who inserted the year-formula knew the true interval of time that had elapsed since the Venus observations, but was in error to the extent of 170 years in his historical chronology, a most improbable supposition. It also ignores the agreement between the intercalations implied on the tablets and those supplied by the contracts of the reign of Ammizaduga. As will be seen, this agreement can be checked throughout the whole reign of Ammizaduga. In 1920 UNGNAD, in ZDMG. 74, p. 425, expressed doubt about the reliability of KUGLER's chronology on the ground that it placed the delivery of dates too late in the year. In support of this view UNGNAD cited VS. xiii 18, which has since appeared as No. 1724 in the sixth volume of his *Hammurabi's Gesetz* (1923). He states that in this document the delivery of dates was fixed for Kislev 1, or, as he thinks, at the same time of year as in late Babylonian times when Nisan 1 fell approximately between the middle of March and the middle of April of the Gregorian calendar. The document selected by UNGNAD was certainly unfortunately chosen. It asks for payment not on Kislev 1, but merely in Kislev, thus permitting the tenant to postpone payment to the last day of Kislev. The document belongs to the 23rd year of Hammurabi, in which year the last day of Kislev would fall on or about December 25 Gregorian according to KUGLER's chronology. This is certainly late for a delivery of dates, but, as LANGDON has pointed out to me, the contract requires the delivery not only of dates, but of planks of wood, and even of 10 talents of palm branches blown down by the wind, which would hardly be available until the winter storms had begun. It may also be noted that even in the Persian period Kislev was an unusually late season for requiring delivery of dates. In 1921 UNGNAD repeated in OLZ. 24, 17, his doubt of the trustworthiness of KUGLER's conclusion, adducing the difficulty of reconciling it with the Assyrian king list as well as its failure to place the date-harvest at the proper season, and expressed a desire to see the rival examination of the Venus tablets which WEIDNER had adumbrated.

So far the strictly astronomical part of KUGLER's reconstruction of the chronology had remained unanswered, and his calendrical study had been questioned on very unconvincing evidence, WEIDNER's argument assuming (1) that the astronomical statements of a neo-Babylonian document represented the state of the calendar under the First Babylonian Dynasty, and (2) that the fixed Nisan of that document was identical with the mean Nisan of the lunar calendar, while UNGNAD's argument rested on a single date-contract, whose relevancy to the calendrical question was at least doubtful. It may, therefore, seem strange that in 1922 KUGLER, in his *Von Moses bis Paulus*, pp. 497-501, announced his conversion to the late date for this dynasty, mainly because of the arguments which WEIDNER and UNGNAD had adduced. The first objection which he brings against his former conclusion is the well-known one that it is inconsistent with the Assyrian chronological tradition<sup>1</sup>, but he regards this as inconclusive in view of the support which it receives from the Babylonian chronological tradition. The second objection is based on the dates of autumn lettings. Seed-time according to his information was in November and December, from which he infers that the latter half of October would be the most likely time for autumn lettings. He finds that the contracts of Arahšamna 20 in the 10th year of Ammizaduga and of Tešrit 28 in the 14th

<sup>1</sup> It will be seen from LANGDON's reconstruction of the Assyrian and Babylonian chronology that there is no such inconsistency.

year of Ammizaduga fall on December 14 and December 8 Gregorian respectively, according to the solution which he had propounded, and he regards these as suspiciously late dates. But, as has been seen, such contracts are distributed throughout the whole year and prove little or nothing. His third objection to his original solution is based on the date-harvest. He argues that the date-harvest must have been in Tešrit, because the division of the crop between landlord and tenants is repeatedly mentioned as due in Arahšamna. He cites one contract for delivery in Arahšamna and one for delivery on Arahšamna 1. He also cites II Raw. 15, 40 c.d., for delivery on Arahšamna 30. He had apparently overlooked LANGDON'S paper, RA. xiv (1917), pp. 16-19, in which this date is shown to belong to a grammatical exercise and to have no bearing on the delivery of dates. KUGLER computes that on his original solution the mean Arahšamna 1 would be November 19 of the Gregorian calendar, which he regards as too late for delivery of dates, since according to him the date-harvest falls in September and October. By reducing his chronology 120 years he thought he would transfer this date to October 15, and by reducing it 176 years he would transfer it to September 28. The argument does not appear to be conclusive, though it suggests that some reduction in the chronology would improve the agreement with date-harvest.

On these grounds KUGLER rejected his original solution and imagined that with it the late Babylonian chronological tradition must also be abandoned. If so, he felt that the Assyrian tradition must be adopted, which he thought inconsistent with a reduction by 120 years only, and he therefore decided on a reduction by 176 years. This had in his eyes, as in WEIDNER'S, the further merit of bringing the vernal equinox into an approximate coincidence with the mean Nisan 1. He did not review the arguments by which he had previously applied the contracts for payments at the time of harvest nor the contracts for hiring labourers. Thus while the rejection of his original theory was based on the contracts bearing on the seasons of the year, his new solution was only preferred to an intermediate solution on the evidence of a supposed Assyrian chronological tradition and on a very doubtful interpretation of a late astronomical text. It was not supported by a single computation of an appearance or disappearance of Venus, but it was naïvely assumed that these phenomena would be separated by the same intervals of time from the conjunction of 1796 B.C. December 1 by which those computed for the original solution were separated from the conjunction of 1971 B.C. January 23.

In 1923 LANGDON published the second volume of the *Oxford Editions of Cuneiform Texts*, including the chronological prism, W. 444. In order to obtain a basis for the reduction of the dates on this prism he requested me to examine the astronomical data on which KUGLER had based his two systems of chronology. The time available before the publication of his work was not sufficient to permit a recomputation of all the observations contained on the tablets, much less to permit a discussion of the motion of Venus in the light of all the ancient observations. But it was clear to me that the table in KUGLER'S *Sternkunde und Sterndienst*, ii 285, on which both his earlier and his later determination of the date of the 6th year of Ammizaduga depended, suffered from two defects: (1) the dates given for conjunction and new moon depended on tables which did not take account of the latest values for the motion of the Sun and Moon, nor of such corrections to the motions of Venus as seemed to be implied in the acceleration of the Sun which I had evaluated from ancient observations; (2) the table took no notice of the duration of invisibility of Venus, but only of the date of conjunction. The duration of invisibility was, as has been seen, computed by KUGLER for his earlier solution, but for no other solution. Since the duration of invisibility at a given place is dependent on the geocentric latitude of the planet,



which in its turn is mainly dependent on the heliocentric latitude of the planet, which is dependent on the distance of the planet from its node, and since at inferior conjunction the longitude of the planet is always exactly  $180^\circ$  different from the longitude of the Sun, the duration of invisibility will depend on the distance of the Sun from the planet's node, but since the node changes its longitude very slowly the duration of invisibility may be said within a range of a few hundred years to depend entirely on the longitude of the Sun, or in other words on the season of the year. It was therefore to be expected that since KUGLER's different solutions placed the conjunction in question at different seasons of the year, they would be accompanied by different geocentric longitudes of Venus and different durations of invisibility. In this way I found that the solutions lying 112 or more years later than KUGLER's earlier solution were inconsistent with an invisibility of three days only. I found that a solution 56 years later than KUGLER's earlier solution would stand the test of the observations in question, and I found that if the apparent acceleration of the Sun's motion were explained by a change in the length of the day and if a corresponding apparent acceleration were assumed in the motion of Venus, Venus would not be visible on the day which KUGLER had originally regarded as the 28th of Arahsamna, the day of her last visibility in the 6th year of Ammizaduga. I therefore inferred that, if this explanation of the solar acceleration was correct, the 6th year of Ammizaduga must have been 1916-1915 B.C. and the 1st year of Ammizaduga, 1921-1920 B.C. This conclusion was published by LANGDON in the preface to the second volume of *Oxford Editions of Cuneiform Texts* (1923).

At that time I was employing HERR CARL SCHOCH of Berlin on the reduction of certain ancient eclipses, and when he had finished this task I thought the most useful work that I could give him would be the reduction of ancient planetary observations, in order to see whether they afforded evidence of an apparent acceleration. SCHOCH computed for me the angular distance of the Sun below the horizon at all late Babylonian observations of first or last visibility of Venus, but as soon as I had introduced him to the Venus tablets his mind began to run on a possible restoration of ancient Babylonian chronology and even on a continuous restoration of the Babylonian calendar by means of the recorded intercalary months. He also formed the idea of using references on contracts to the 30th day of a month as a test for the computed interval between two successive first appearances of the lunar crescent, thus providing a new astronomical criterion for deciding between rival restorations of the Babylonian calendar. In the hope of obtaining more information than was given in KUGLER's *Sternkunde und Sterndienst* about contracts containing intercalary months he entered into a private correspondence with KUGLER, and thus provided that scholar with material which he partly misunderstood and which he used in his *Sternkunde und Sterndienst in Babel*, Buch II, Teil II, Heft 2 (1924), pp. 622-7. This Heft is a valuable contribution to the chronology of the last nine centuries before Christ, but also contains, on pp. 563-71, a discussion of early Babylonian chronology, which reproduced with small verbal changes the discussion which had already appeared in *Von Moses bis Paulus*. The earlier parts of the Heft would appear to have been printed off before KUGLER had arrived at his new conclusions, and it is only in the concluding pages that notice is taken of my work. The computations, but not the conclusions, contained in those pages are due to SCHOCH, who had compiled, in 1922, tables for the rapid computation of the phases of the Sun, Moon, and planets, and who had also compiled tables for computing the first visibility of the moon, based on late Babylonian data. He also constructed, in 1924, tables for the rapid conversion of Babylonian dates into dates of the Julian calendar, in which the inequalities in the Moon's



motion and the irregularity of Babylonian intercalation are disregarded, but which will in about 80% of cases place the beginning of a Babylonian month on the right day, though there is room for an error of one day, and though it may sometimes be necessary to re-identify the months according to the theory that is adopted of their position in the natural year and of Babylonian intercalation.<sup>1</sup> KUGLER's study will be noticed in its proper place so far as is necessary for the purposes of the present work. In June 1924 I engaged SCHOCH to come to Oxford to assist me in a study of the whole problem. Before leaving Germany he had on his own account contributed a brief note on the bearing of astronomy on the subject to *Astronomische Nachrichten*, Band 222 (1924), pp. 27, 28, in which he stated that according to his tables a last visibility of Venus on the evening of Arahšamna 28 followed by a reappearance on Kislev 1 was possible only in 1971 and 1915 B.C. within the 3,000 years following 3000 B.C. He himself regarded 1915 B.C. as the correct date.

The present study is largely the result of SCHOCH's co-operation with me. Almost all the astronomical computations were made by SCHOCH with the aid of his own tables; the restoration of the calendar is my own work, and supersedes a restoration which SCHOCH had attempted with less complete material. The references to 30-day months were collected by SCHOCH and have been verified and revised by me with LANGDON's assistance. The subject was a matter of daily discussion between SCHOCH and myself while he resided with me from June to December 1924. In October 1924 we learned from DR., now PROFESSOR, SCHNABEL that he had discovered that K. 7072 and Rm. 134 were fragments of Document M, and he afterwards drew our attention to the value of the fragments contained in Rm. II, 531, and S. 174.<sup>2</sup> With the aid of the two first-named of these tablets together with the omens, which SCHIAPARELLI and KUGLER had ignored, he drew the conclusion that M contains the same observations as L, but that, whereas they are arranged in chronological order in L, they are arranged in calendrical order in M. He also emphasized the importance of the omens for the reconstruction of the text. In December 1924 M. THUREAU-DANGIN communicated to SCHOCH at the joint request of SCHOCH and LANGDON for use in our work a number of unpublished contracts for division of date-crops belonging to the later years of Hammurabi. We also had the benefit of a revised collation and translation of K. 160 and K. 2321 + K. 3032 by LANGDON, and of his translation of K. 7072, Rm. 134, and Rm. II, 531. After returning to Germany SCHOCH published on his own responsibility a condensed study of the whole chronological question and concluded in favour of a chronology falling 64 years later than that which I had proposed. This work appeared under the title of *Ammizaduga*, von C. SCHOCH, Selbstverlag, Berlin-Steglitz, Kuhlighshof 5, 1925. A review of the literature of the subject with a brief announcement of his own views and contributions was published by SCHNABEL in ZA. xxxvi (1925), pp. 109-22, in which he concluded in favour of the chronology which I had proposed. SCHOCH came to the same conclusion in a paper entitled 'Die erste Dynastie von Babylon', *Klio* xx (1925), pp. 107-9.

Since SCHOCH's papers consist mainly of work which he had done for me as my assistant and since SCHNABEL's paper apart from the history of the subject consists mainly of work privately communicated to me which became inseparably united with my own studies, their work will be incorporated in the present study without separate discussion here.

<sup>1</sup> These tables appear in a revised form as an appendix to the present volume.

<sup>2</sup> WEIDNER had informed him that he had recognized that

S. 174 must be a fragment of one of these texts and SCHNABEL had identified it as a fragment of Document M.

MEYER published in 1925 a 'Nachtrag' to the first volume of his *Geschichte des Altertums* under the title *Die ältere Chronologie Babylonians, Assyriens und Ägyptens*. He acknowledges the force of the arguments in favour of the solution which I had proposed, but in view of the errors which appear to exist in the Venus tablets and of the doubt attaching to any restoration of the chronology where the series of intercalations is not known for certain, and in view of his preference on historical grounds for a shorter system of chronology, he leaves the question undecided between KUGLER's solution published in 1922 and mine published in 1923.

In *The Illustrated London News*, Oct. 10, 1925, p. 666, LANGDON announced that in 1924 a fragment of a clay tablet had been excavated at Kish, completing the text contained on K. 2321. Photographs of the obverse of both tablets were included in his article.